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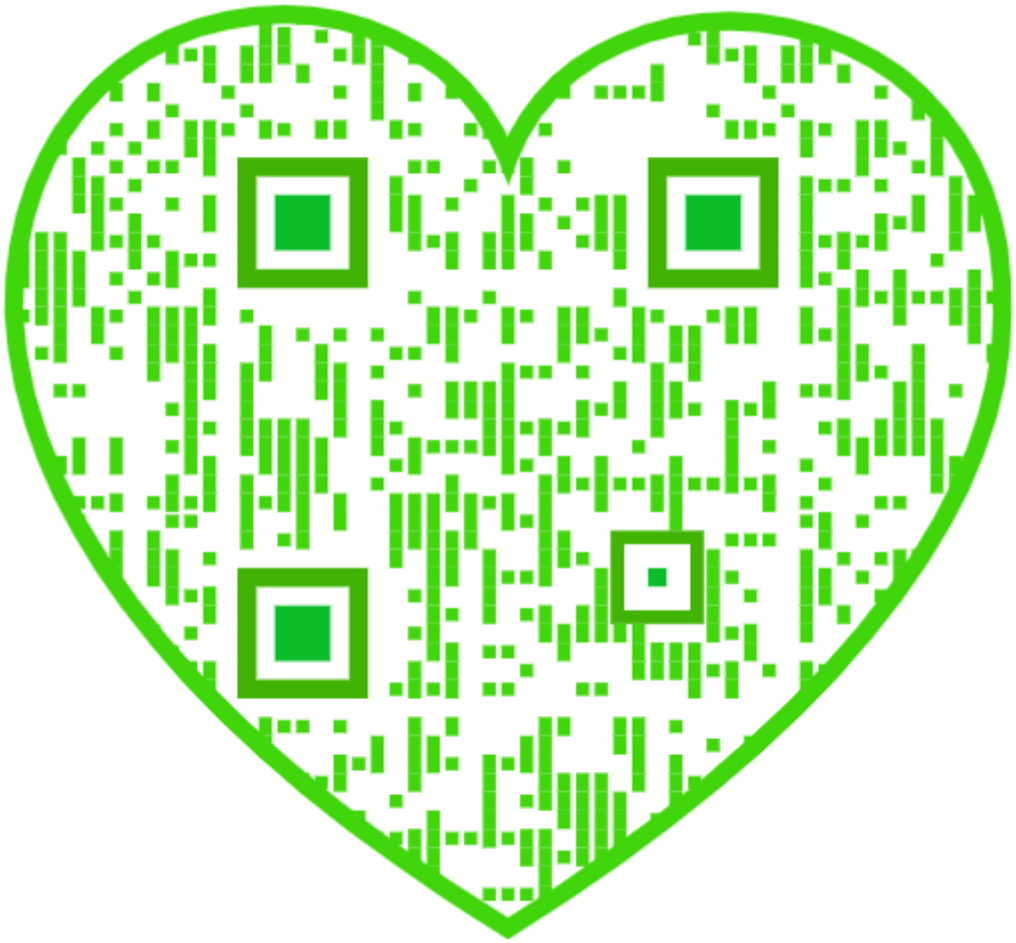
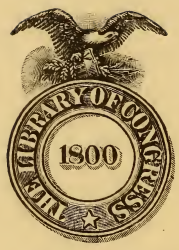
PLASTER of PARIS and how to use it

By MARTIN W. WARE M.D.





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PLASTER OF PARIS

AND

HOW TO USE IT

BY

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PREFACE

The material for the subject-matter of this book is based on ten years' dispensary practice in the very large joint disease and fracture service (5,000 cases) of the Good Samaritan Dispensary.

The embodiment in book form of this experience and of what has heretofore been but a fragmentary consideration of the subject is due to the suggestion of Dr. Walter M. Brickner, Chief of the Surgical Out-patient Department, Mt. Sinai Hospital, whose valuable assistance in editing these pages is hereby thankfully acknowledged. Thanks are due to Dr. Maurice Green for his aid in the preparation of the chapter on Plaster of Paris in Dental Surgery. The illustrations are for the most part reproduced by Dr. Erwin Reissman from original photographs and sketches; others from standard textbooks of surgery.

MARTIN W. WARE.

1198 *Lexington Avenue, December,* 1906.

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CHAPTER I

THE PLASTER OF PARIS BANDAGE

Materials

The very widespread use of the plaster of Paris bandage in hospital and dispensary practice for purposes of fixation and immobilization of fractured bones and diseased joints is in decided contrast to its limited use in private practice. An inquiry into the reasons therefor finds its best answer in the statement that the plaster of Paris bandage found on the market does not usually come up to the requirements. Therefore a description of what constitutes a properly made plaster of Paris bandage is of the first importance.

The plaster of Paris used in the making of the bandage should be of the superior quality used by dentists, and the quick-setting kind is to be preferred. It is sold packed in tin cans to prevent deterioration (oxidation) by absorption of water from the air; and for a like reason it must be stored in places free from moisture when once the original package has been opened.

Any one of a number of different fabrics may be employed as a substratum in preparing the bandage, such as *gauzes, crinolin* (gauze impregnated with starch), *dextrine gauze* and *flannel.*

The use of plain gauze or muslin is undesirable because the plaster sets very rapidly, and becomes too brittle. On

the other hand, a gauze too rich in starch or dextrine will wholly prevent the plaster from setting. The mesh of the gauze should be 28x32 threads to the square inch. The best kind of gauze is white crinoline without cross-bars.

Manufacture of the Bandage

The superior plaster of Paris bandage is *made by hand*, for the reason that, made in this way, the right quantity of plaster can be incorporated in the bandage. The crino-

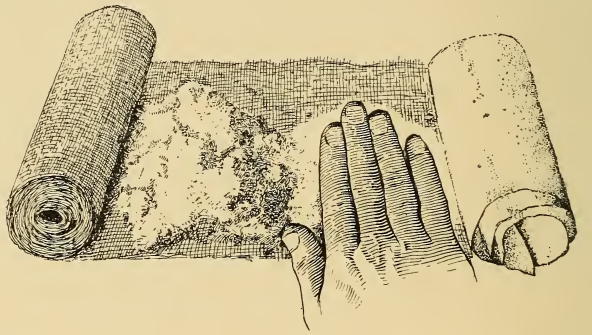

Fig. 1. Preparing plaster bandage by hand.

line is cut into strips of the widths desired, and loosely rolled in ten-yard lengths. One yard at a time being unrolled, a handful of plaster of Paris is rubbed into the gauze with the palmar surface of the fingers, so that all excess of plaster passes to either edge of the bandage. (See Fig. 1.) No more plaster should be rubbed into the dextrine gauze than the meshes will hold, and as each successive yard is incorporated with the necessary quantity of plaster it is *loosely rolled* in such manner that in the center of the bandage there is a hollow cylinder of the thickness of the finger, and *the concentric layers are easily movable on one another.* This arrangement permits the rapid and uniform spread of the water

through the bandage, and prevents parts of the bandage from being insufficiently moistened. To guard against unraveling, a pin should be inserted in the last turn.

Storage

The completed bandages should be placed on end and sealed in individual tins in the bottom of which a small quantity of plaster of Paris is placed, or, likewise arranged on end, they may be packed in bulk in large tin containers. If the plaster cannot be stored in a dry place, it is advisable to wrap each bandage in wax paper or gutta percha tissue, newspaper also answers, and, in any case, it is a wise precaution to seal the can with a strip of adhesive plaster, passed about the overlapping edge of the cover. The individual tins or tin containers protect the bandages from moisture, and, furthermore, permit them to be placed in ovens, as a preliminary to using them, in order to drive off any moisture.

Bandages of Commerce

A very rigid plaster of Paris bandage has recently been put on the market. It is made of exceedingly fine flexible *aluminum bronze wire netting* and is sold in widths of one and one-half, two and one-half, three and one-half and four inches, in four-yard lengths. It is applied in the same manner as the regulation plaster bandage. The disadvantages common to the plaster of Paris bandages of the shops are that the fabric is not of the dextrine order; the mesh is too closely woven—the plaster lies on the bandage instead of in the meshes—and as a consequence, there is an excess of plaster; the bandages are, as a rule, so tightly rolled that the water does not reach the deeper layers. These are the bad features of the machine-made bandage. It is manufactured by dragging the strip of muslin through a compartment filled with plaster of Paris, and winding it upon a windlass. (Fig. 2.)

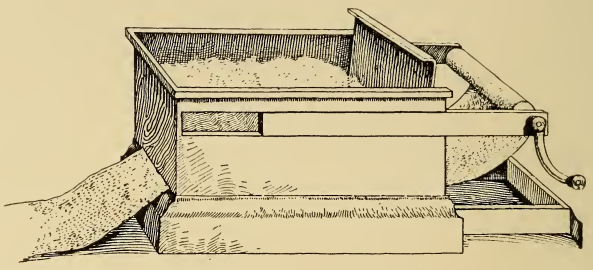

Fig. 2. Plaster of Paris cradle.

Molded Splints

A form of plaster dressing, well adapted to the making of molded splints, can be obtained by dipping strands of hemp jute (Beeley), flax or straw, of about the width of the finger, in a cream of plaster of Paris. This is by far the cheapest form of plaster of Paris dressing. Cotton, impregnated with plaster of Paris and placed in seamless sacks of tricot, constitutes another method of making molded splints (Breiger). A modification of the Beeley hemp splints consists in placing into a sheath of tricot or the leg of a stocking, a bundle of thoroughly beaten hemp strands, steeped in plaster cream. This sausage-shaped mass is thoroughly kneaded and molded to the parts (Turner). Other fabrics like sail-cloth, which contain sizing material, are also useful for making molded splints; and I have found the fabric known as "Deimel linen mesh" suitable for making molded plaster of Paris splints.

Protection from Soiling

Before starting to apply the bandage, the surgeon and his assistants should be properly gowned. In every instance the forearms should be bared, so as to permit the greatest freedom of motion in applying the bandage. To protect the clothing from being soiled, a rubber apron

or gown should be worn (Fig. 3), or the latter may be improvised from a bed-sheet. Either one should extend to the collar, and it should be sufficiently long to cover the feet, or a pair of rubbers should be slipped over the shoes.

In private practice especially it is also necessary to protect the surroundings from soiling by the plaster of

Fig. 3. Plaster bandage lifted from water, squeezed, and free end opened. Manner of handing it to surgeon. (From W. M. Brickner's "THE SURGICAL ASSISTANT." By courtesy of the publisher.)

Paris. The floor, the patient's body, and the couch of table on which the patient is placed should be covered with muslin, gunny sacks, bed sheets or a rubber sheet. When these are not available, tar paper, newspaper, or ordinary wrapping paper will serve the purpose.

THE IMMEDIATE PREPARATION OF THE BANDAGES FOR USE

The number of bandages intended for use should be removed from the tin container and stood upon end

within a foot of the vessel holding the water in which they are to be immersed. The tin container, uncovered, is to be within arm's reach, in case necessity arise to use more bandages. The bandages to be used are to be placed to the right and the container to the left. This arrangement guards against particles of water being spattered upon the bandages still in the container, rendering them unfit for subsequent use.

Fig. 4. Freeing bandage of frayed edges. (From W. M. Brickner's "The Surgical Assistant." By courtesy of the publisher.)

The vessel in which the bandages are to be immersed should be deep enough to accommodate the widest bandage vertically. But one bandage at a time should be immersed. It is to be placed endwise in the vessel, which contains water as hot as the hand will tolerate. The bandage must be completely submerged, and it should remain so until the bubbles cease to come off. This will

take place most readily in the very loosely rolled bandages. The tightly rolled bandages obtained in the shops should therefore be unrolled and rendered loose before they are wet. When the bubbling has ceased, the bandage is lifted out of the vessel, and squeezed with the hand, merely to free it of the excess of water. In some bandages the edge of the crinoline frays out, and becomes so entangled as to hinder the free unrolling of the bandage. To prevent this, the frayed out ends should be plucked from each side before starting to apply the bandage. (Fig. 4.)

Chemical Adjuvants

To hasten the setting of the bandage, some manufacturers recommend the addition of salt or alum to the hot water. This is not advantageous inasmuch as the bandage often sets in the hand before it is unrolled. With the home-made bandage prepared, as previously described, with the best quick-setting plaster, the addition of chemicals to the water is superfluous.

Protection of the Skin

The skin has to be protected from the plaster of Paris. This may be accomplished in various ways. The area to be encased in the plaster of Paris bandage may be wrapped in cotton wool. The drawback to this is that the cotton becomes "caked" and the bandage subsequently loosens. Better than this is the use of a flannel bandage, or the "ideal bandage," which is to be applied smoothly, without wrinkles and without "reverses," for these are apt to exert pressure on the soft parts beneath when the weight of the plaster is brought to bear. An elegant investment of the skin is afforded by the use of seamless tricot hose, which can be had in various widths and is applicable to the trunk or extremities. For the latter a comfortably fitting sock, stocking, undershirt sleeve or

drawer leg may be used. When the plaster bandage is applied to serve as a cast, the limb need merely be anointed with vaseline.

Application and Precautions

No undue traction should be made in applying the successive turns of the bandage. The use of any other than a light hand, when unrolling the bandage on to the member, will be followed by such constriction of the limb and interference with circulation, with the setting of the plaster, that its prompt removal will probably be required.

In fractures, if the swelling be very marked, if there be evidence that the extravasation has not attained its maximum, the limb should be elevated and subjected to the compression of a rubber bandage, and this should be followed by gentle massage, before the plaster bandage is applied. On the other hand, it should be borne in mind that usually several hours elapse after the injury before the surgeon has been called and has made preparations to apply the plaster, and generally, therefore, there need be no dread of an increased swelling beneath the bandage. Indeed, the best means of limiting the swelling after a fracture is the prompt application of a plaster of Paris bandage. If there be any concern that the plaster bandage has set too tight, or will do so, this may be remedied in the following manner: While the plaster is yet soft, cut through the entire length of the bandage with a penknife, and with the bandage shears also divide the bandage, cotton or tricot, underneath. The subsequent contraction of the plaster in the act of hardening will cause a further widening in the furrow made with the penknife, and thus relieve the pressure existing. In fact, where the circumstances are such that the bandage cannot be inspected within the first twenty-four hours after its application, it should always be the practice to divide the

plaster as described, in order to forestall any possible unpleasant developments.

To guard against a loosening of the plaster of Paris bandage, as the furrow widens, strips of adhesive plaster may be drawn across the gap to limit it, and then a stout muslin bandage applied over the whole plaster dressing. Some days later, when the bandage has adjusted itself to the underlying parts, and the swelling has subsided, the adhesive strips may be drawn tight enough to obliterate the furrow and make the bandage fit snugly.

Marked bony prominences that have to be covered by the plaster should be protected with a layer of cotton before applying the flannel bandage or tricot hose. As each successive turn of the plaster bandage is applied it should be smoothed, always in the same direction, by friction of the hand, moistened occasionally with water. If the bandage be properly made, at no time is it necessary to rub in any loose dry plaster, or any paste of plaster that settles in the vessel. In fact, this excess of plaster, when it sets, adds unnecessary weight to the bandage, and lying between the layers of gauze, as it does, and not incorporated with the fibre, it renders the dressing brittle. The outer layers of the plaster bandage are apt to chip, and these loosened particles irritate the skin and soil the garments and surroundings. To obviate this, the finished plaster of Paris dressing should be covered the day after it is applied with a single layer of dextrine bandage, which is moistened and made limp before it is applied, but soon becomes dry and hard again.

The plaster of Paris bandage may be applied to a member in continuity or in sections. In the former method, the bandages are wound spirally up and down the length of the limb without reverses until each roll of bandage is exhausted, and a number of bandages is used to cover the same ground until all parts are sufficiently covered. In the latter method, the limb is divided off into segments and each segment is separately invested with one or two

bandages, according to requirements; each section of plaster overlapping the adjoining one. The former method provides a stronger dressing.

The finished bandage should be exposed to the air to effect a thorough hardening. When a hot air apparatus is at hand the whole member may be baked for one-half hour.

The upper and lower limits of the plaster bandage must not extend beyond the bandage enveloping the skin. An

Fig. 5. Illustrating the cuff of cotton at the upper and lower limits of the plaster of Paris bandage.

elegant finish may be given to the edges of a plaster dressing by turning over its ends, in cuff-like fashion, the ends of the flannel bandage. This device must be borne in mind while the plaster is being applied, so that the final turns of plaster at either end may securely hold in place the retroverted fold of flannel bandage. Equally efficient in preventing the ends of plaster from impinging on the skin is a cuff of cotton held in the grasp of the last turns of plaster at either end. (Fig. 5.)

When the flexure of a joint is encroached upon by the plaster, a crescentic section may have to be removed from the latter in order to allow free motion of the joint. This had better be done while the dressing is in the plastic state. Again, with the bandage in the plastic state, it can be molded by the pressure of the finger and hands with massage-like motions, to conform it to the contour of the limb. To bring about an adaptation this molding is far superior to, and less dangerous than, the employment of traction on the plaster bandage.

Fig. 6. A strip of metal one-half inch wide incorporated in the bandage.

Removal of the Plaster Bandage

Some deem it expedient to place a piece of metal one-half inch wide (Fig. 6), or a wire, on the limb before starting the plaster bandage, and to allow the metal ends

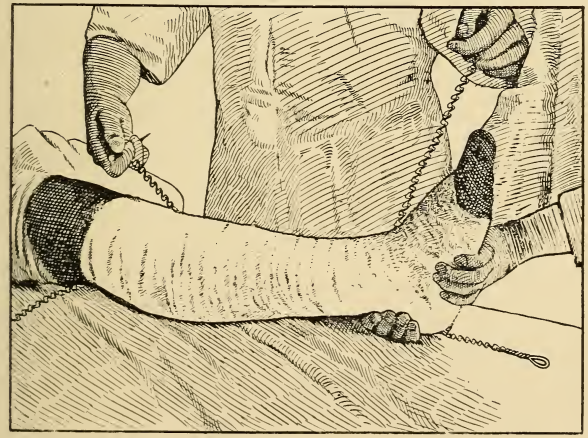

Fig. 7. Illustration of method of dividing plaster cast with Gigli saws placed under the bandages.

to protrude as a guide where to start cutting the bandage. The metal beneath is to guard the skin against being cut

by strokes of the knife. It has also been recommended to place a Gigli saw (Figs. 7 and 8) on the limb, before applying the plaster. To the protruding ends of the saw metal handles are to be attached, and with the aid of these the wire is set in motion and the plaster divided from beneath. Even though this saw is constructed of aluminum bronze it is liable to corrosion and does not work freely.

Fig. 8. Plaster of Paris cast removed in lateral halves, having been cut through front and back with mitre or Gigli saw.

If it is the intention to utilize the plaster of Paris bandage again, care must be taken to preserve its integrity. This can be best accomplished by cutting a furrow (Fig. 9) into the plaster in its entire length with a penknife, or, more expeditiously performed, with a *mitre saw*. (Fig. 10.) The fabric beneath the plaster constitutes an impediment to the free motion of the saw and therefore gives indication when the plaster is divided, and thus

Fig. 9. Showing the grooves cut in the plaster cast with the mitre saw.

prevents injury to the soft parts beneath. When the penknife is used, the dropping of acetic acid (or vinegar) on the plaster, along the path of the knife, will lighten the otherwise irksome task.

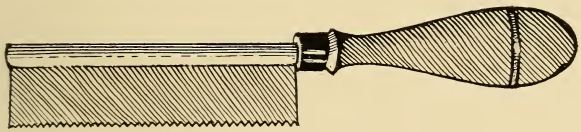

Fig. 10. Mitre saw.

All complicated devices of the circular saw are useless, as the mechanism becomes blocked with particles of plaster.

A very effective instrument for cutting a furrow in the plaster bandage are Stilles' shears. (Fig. 11.) The

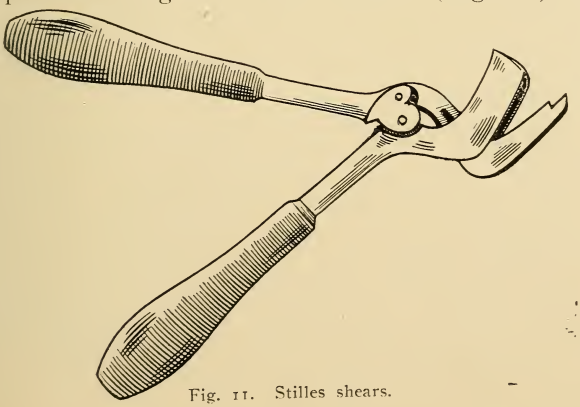

Fig. 11. Stilles shears.

section of bandage removed falls out of the window of the cutting blade. These shears are constructed like some of the bone cutting forceps, but they are not at all serviceable in passing about an angle like the ankle joint.

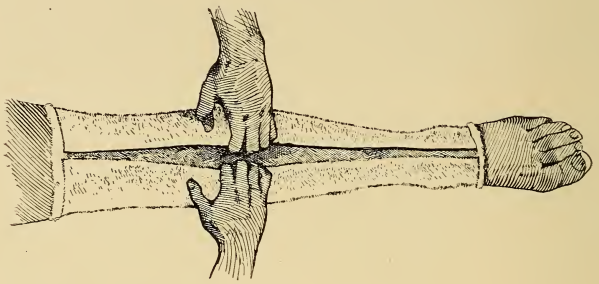

Fig. 12. Manner of removing the cast from the limb.

After the plaster is divided at every level, the bandage beneath is divided with shears. Now the whole cast may be lifted from the limb, much in the manner that a hoop is sprung from a barrel (Fig. 12), or by a motion similar to the opening of calipers. The flannel bandage is adherent to the plaster and comes away with it.

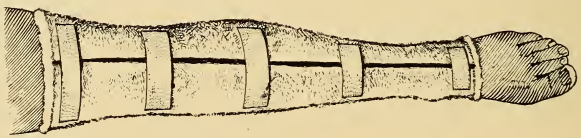

Fig 13. Illustrating manner of reapplying the cast with adhesive straps.

Replacement of the Cast

Eventually the cast may be lined with absorbent cotton, or the limb invested with another flannel bandage before replacing the cast. Straps of adhesive plaster are applied circularly over the plaster cast (Fig. 13) and the whole recovered with a moistened dextrine bandage.

Toilet After Bandage is Completed

Such plaster of Paris as may have been spattered on clothing, carpets or fabrics had best be allowed to dry thoroughly before an attempt is made to remove it. The spots on furniture or wood-work had best be removed while moist, or if dry, they should be moistened. If not much time has been consumed in applying the plaster of Paris bandage, and the plaster on the surgeon's hands is still moist, it can be readily washed off in warm running water. If it be dry, however, friction of the hands with granulated sugar will speedily dissolve the plaster. Friction with salt will effect a speedy removal by rendering the plaster more brittle, and the same may be said of ablutions with bichloride of mercury.

Disposal of Refuse

The discarded portions of plaster bandage and excess of loose plaster should be cast away with household refuse. The water used for immersing the bandages should be decanted from the plaster paste in the bottom of the vessel and emptied into a sink or privy, which is then to be flushed with hot water, preferably from the tap. Under no circumstances should the paste from the vessel be emptied into the waste-pipe, for it is likely to choke it up. The paste, if immediately attended to, may be loosened by shaking the vessel or by imparting a smart blow to it. If this does not suffice, or if the vessel be porcelain, the adherent masses may be lifted or scraped off with a piece of wood or a knife. The addition of water, hot preferably, will aid in loosening the plaster. The whole mass is to be thrown away with other household refuse or to be incinerated in a furnace.

CHAPTER II

THE APPLICATION OF THE PLASTER OF PARIS BANDAGE TO INDIVIDUAL FRACTURES

Fractures Suitable for Plaster

There is hardly a fracture of any bone in the body requiring immobilization, for which the use of the plaster bandage has not been advocated. Enthusiasts, indeed, would have us use plaster bandages for all fractures. An enumeration of the fractures for which the plaster bandage is neither desirable nor practical will best show its limitations. These are: fractures of the skull (for obvious reasons); of the wrist (Colles); of the clavicle; of the ribs; of the shaft of the femur in infancy, in all cases, and in adolescence, in most cases. In all other fractures the use of a plaster of Paris cast is in place. In fractures of the forearm and arm in infants, because of the small dimensions of the parts, plaster of Paris is always to be preferred to splints. The X-rays readily penetrate the plaster, so no objection can be offered to its use on this score. Except when applied to the lower extremities, its weight can be kept down to that of any variety of splint.

General Considerations

The immediate use of plaster of Paris for fractures does not imply its instant application. Usually, several hours elapse before the bandage is applied; by which time the swelling about the fracture will have attained its

maximum. If it is desired to reduce this swelling, or keep it at its minimum, elevation, massage, the use of a flannel or rubber bandage, preliminary to the application of the plaster bandage, will accomplish this. In the use of the plaster of Paris bandage, perhaps more so than with other sorts of splints, an anesthetic is often required, and for the following reason: If the patient be at all restless while the deformity is being corrected and alignment maintained, it is very likely that the plaster bandage will be put on with undue pressure; and violent motions of the patient may crack the quickly-setting plaster. If swelling of the fingers or toes or of the extremities distal to the bandage should supervene, the immediate removal of the bandage is by no means always necessary. Before taking this step we should be guided by the color, warmth, and amount of pain. If the extremity be cold, blue, anesthetic, or extremely painful, and a pulse cannot be felt, there should be no hesitancy in the instant loosening of the cast by splitting it. On the other hand, if, in spite of the swelling, the limb be warm, and not unduly red (inflammation excluded), and the accompanying pain and throbbing be a source of great discomfort, it is desirable to resort to the expedient of elevating the entire member by suspension or by placing it upon cushions, and to secure absolute rest by the administration of an opiate. If, after recourse to these measures for twenty-four hours at the utmost, the pain persists or is worse, and especially if the warmth of the extremities gives place to cold, the cast must be split forthwith. Great caution must be exercised when these evidences of circulatory disturbances—swelling, edema, lividity—manifest themselves; for neglect to visit the patient frequently may cost him his limb and the surgeon his reputation. It need not necessarily follow that the limb becomes gangrenous—a fate just as bad awaits a limb encased in plaster of Paris, when the patient complains of paresthesia and anesthesia. The undue pressure of the plaster

of Paris, responsible for these symptoms, will, if not removed, cause *ischemic paralysis,* terminating in permanent contractures. *A mere splitting of the cast* in its entire length will put an end to all the untoward symptoms just mentioned.

Under the most favorable circumstances, in the course of a week or two, with the subsidence of the swelling the cast may become so loose that it is necessary to remove it, either to pad its interior with non-absorbent cotton, or to make a thicker investment of the limb; after either of which the cast may be replaced. An undue amount of perspiration with severe itching, or the presence of a solid substance which had accidentally made its way beneath the plaster, also demands the removal of the cast.

Posture

When applying a plaster bandage for fracture, whether to upper or lower extremity, the body must be in a *recumbent position.* The arm, leg or thigh to be bandaged should project beyond the edge of the table and be supported by an assistant. It is impossible to apply a plaster bandage to the extremities of an infant struggling in the arms of its mother or nurse; nor is the sitting posture in an adult conducive to that relaxation of the muscles necessary for the proper application of the bandage to the extremities.

CHAPTER III

FRACTURES OF THE UPPER EXTREMITY

Fracture of One or Both Bones of Forearm

The patient should be placed on his back, with the body close to the edge of the table, and both forearm and arm extending beyond the edge, supported by an assistant.

Fig. 14. Application of plaster of Paris bandage for fracture of the forearm.

(Fig. 14.) The deformity is reduced by manipulating the fragments, making extension and flexion in the antero-posterior or lateral direction, associated with supination or rotation. The proper alignment accomplished (an anesthetic to be administered if necessary), the assistant grasps the patient's hand, as in the act of hand-

shaking, making traction and executing counter-extension if necessary, or merely supporting the forearm—whichever is necessary to maintain the alignment. The plaster bandage should extend from the wrist to the flexure of the elbow. The flannel bandage immediately investing the forearm, however, should extend to the heads of the metacarpal bones, thus enveloping the hand. The fingers are left free. Thus we prevent edema of the dorsum of the hand, and by the color of the fingers we may judge of the circulation. If the fracture of the radius or ulna, or of both bones, be in the upper third, it may be necessary to flex the forearm on the arm. In that event the plaster of Paris bandage will include the elbow, and must be carried up the arm as far as the fold of the pectoral muscle, to secure the right purchase. If the bandage on the arm extends only a little above the level of the elbow joint or half way up the arm, the weight of the plaster bandage on the forearm, by breaking up the flexion, will cause the upper part of the bandage to press into the soft parts. The flexure of the elbow should be well cleansed, dried and dusted freely with bismuth subgallate (dermatol), before the bandaging, to prevent chafing (dermatitis).

Fracture of Shaft of Humerus

In fracture of the shaft of the humerus in its middle or lower third, when we are not concerned with the abduction of the upper fragment, a plaster of Paris dressing is suitable. The patient occupies a sitting posture. The reduction having been effected, the limb is brought into adduction, so that the chest wall forms an internal splint. A thin layer of non-absorbent cotton, well ducted on both sides with dermatol, being interposed between the arm and the chest wall, the arm is held in place by circular turns of a muslin bandage, which pass obliquely over the shoulder, enveloping it. The forearm is left free, so that by its weight, even though supported by a

sling about the wrist, it exerts extension on the lower fragment. In the same manner, the plaster of Paris bandage envelopes the arm and shoulder, securing them to the chest. A layer of cotton wool should be placed over the clavicle and shoulder, to prevent pressure by the plaster bandage. For infants but one bandage, five yards in length, is necessary; for adults, two will suffice. The forearm should be snugly wound with a flannel bandage, to prevent the development of edema.

Fracture of the Elbow Joint

Experience has taught that the plaster dressing is not well suited to fracture of the elbow joint, other dressings being better adapted. When, however, the plaster bandage is chosen, the following steps in its application should be observed. The patient occupies a recumbent position, and the arm, projecting beyond the edge of the table, is supported by an assistant. The forearm is flexed as acutely as possible. In the flexure of the elbow joint, freely dusted with dermatol, a thin layer of cotton batting is placed, and the bony prominences are also enveloped in non-absorbent cotton. The arm and forearm, from the axillary fold to the wrist, are invested with a flannel bandage, and over this, in turn, a plaster of Paris bandage is placed. (Fig. 15.) The plaster bandage does not cover the upper and lower limits of the flannel bandage. These are turned back so as to form a cuff at either end, a single turn of the plaster bandage being sufficient to secure them. This cuff prevents the edge of the plaster from pressing into the skin, and guards against unraveling of the flannel bandage.

Colles' Fracture

In all respects the plaster bandage is to be applied here like the cast described for fracture of one or both bones

of the forearm, save that the wrist is included, and the bandage is carried down to the heads of the metacarpal bones.

Caution: It is this immobilization of the wrist, however, which constitutes a great drawback to the use of plaster of Paris in this fracture, for which many other devices are far better suited.

Fig. 15. Plaster cast for lower third of the arm, the elbow, or the upper third of the forearm.

Fracture of the Thumb

This is the one finger for which, if it is fractured in any of its parts, a plaster of Paris dressing is suitable. Whether the first or second phalanx or the metacarpal bone, is fractured, the thumb, in the extended and abducted position, is covered with a flannel bandage spica, passing in figure-of-eight turns about the wrist, or a cotton glove, with the other fingers cut off, is slipped

over the hand. Either investment is covered with a "spica pollicis" of plaster of Paris, including the wrist and terminating an inch above it. (Fig. 16.) As in all other casts, the edge of the plaster bandage is covered with the last turn of the flannel bandage.

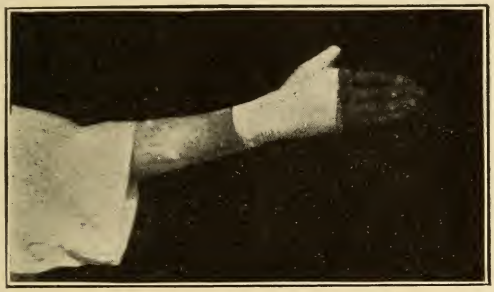

Fig. 16. Cast for fracture of the thumb or carpal bones. Dorsal view.

Fracture of the Metacarpal and Carpal Bones

If the fracture be in the shaft, or near or in the base of the metacarpal bones, or in a carpal bone, the hand, exclusive of the fingers but inclusive of the wrist and two inches of the forearm, is invested with a flannel bandage, and this in turn, is covered with a plaster of Paris bandage two inches in width. (Fig. 17.)

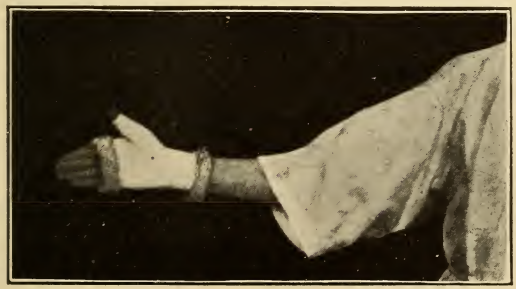

Fig. 17. Cast for fracture of the thumb or carpal bones. Palmar view showing cuffs of cotton at each end.

Time Limit for Removal of Plaster Casts in Fractures of Upper Extremity

While no general rule can be formulated as to when the cast should be wholly set aside in each of the fractures considered, it should be the practice at the end of the second week to remove the cast and inspect the site of fracture. This is done to ascertain, not so much the extent of union as judged by the wanton practice of manipulation to elicit mobility, but rather to note whether the alignment is the best possible. For neither a plaster of Paris cast nor any other splint is designed to correct any deformity, but only to hold the correctly placed fragments *in situ*.

When the X-rays are available, and by their use it is clearly seen, perhaps on the fluoroscopic screen, but preferably in radiograms, that the apposition of the fragments is all that could be desired, we may forego the removal of the cast for the purpose of inspection.

CHAPTER IV

FRACTURES OF THE LOWER EXTREMITIES

General Rule

Every cast applied for fracture of the hip, thigh, knee, or leg should include the foot in a right-angled position. Failure to do this will cause drop-foot (talipes equinus), which constitutes a hindrance to walking during the time that the cast is in place, and delays walking after its removal. In neglected instances, indeed, this drop-foot requires correction and the application of a plaster cast to maintain the proper position.

Fracture at the Hip Joint

The use of a plaster cast in fractures of the senile hip is indicated only if it is possible to have the patient walk about on crutches. Other devices are more effective, but at times not applicable, because they necessitate the patient assuming a recumbent position for many weeks, which is apt to cause hypostatic congestion of the lungs. The most effective plaster dressing is that which includes the knee and ankle, enveloping the hip in a spica, the upper limits of which include the ribs below the mammary level.

Plaster of Paris Hip Spica

The patient occupies the recumbent posture, on a kitchen table or a board resting on two horses. The pelvis must be well down to the edge of the table, the sound limb hanging over the edge and resting with its foot on some support. The affected limb is held by an assistant, who exerts extension. To prevent the displacement of the body by the traction efforts, the lower end

of the table may be raised. In addition, a sling made of a twisted bed sheet, is passed beneath the crutch (perineum) and its ends secured to one of the further legs of the table, or held by another assistant, to exert counter extension. For that part of the dressing which invests the lower part of the thigh, the knee, leg and ankle, the pelvis may rest flat on the table, but while the turns of the spica are applied, the pelvis must be elevated, the shoulders remaining in contact with the table. This can be accomplished in a variety of ways—by an apparatus such as a hip-rest or by improvised devices. Of the former, the one here illustrated, made of a band of iron bent as shown (Fig. 18), and screwed to a plank, is

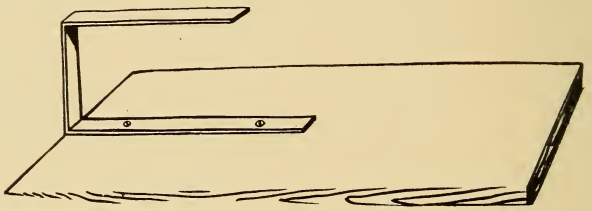

Fig. 18. Metal hip rest, screwed to board.

pushed under the pelvis. The blade supporting the pelvis is covered in by the turns of the plaster bandages, but it can be easily withdrawn after the plaster has set. Where no hip rest is at hand a sling of stout muslin playing about a pulley secured overhead, may be used to raise the pelvis, the loop of the sling becoming incorporated in the bandage. In other instances the pelvis must be supported by hands, or on the superimposed fists of an assistant (Fig. 19), or an agate ware basin reversed. These preliminaries effected, the bony prominences of the spines and crest of each ilium are covered with cotton batting or pads of piano felt. A flannel bandage now invests the foot, leg, thigh, hip, waist and lower thorax.

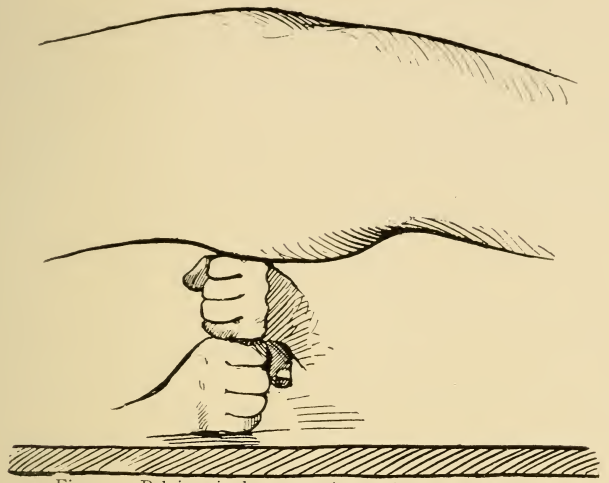

Fig. 19. Pelvis raised on superimposed fists of assistant.

Over this the plaster of Paris bandage is applied. (Fig. 20.) A narrow strip of piano felt is desirable about the

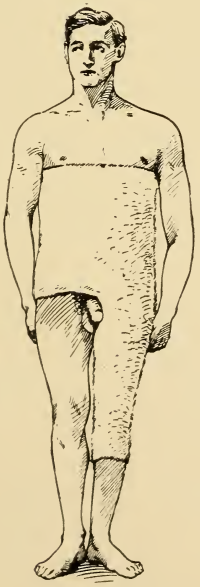

Fig. 20. Plaster spica of hip.

waist to fill out the hollow, for in this situation the spica is very likely to crack. This accident may also be guarded against by increasing the turns of the bandage at that level. The perineum must be particularly guarded by proper padding, and if the turns of the bandage hug it too closely a crescentic segment must eventually be removed to avoid the production of a pressure sore. This part, also, must be well dusted with dermatol or talcum, and either one of these powders is to be blown in under the upper margin and about the pubis, to prevent irritation of the skin. That part of the cast in the vicinity of the genitals may be coated with shellac so that urine or vaginal secretions does not penetrate the cast, rendering it foul and brittle.

In children, fracture of the neck of the femur is associated with adduction of the thigh. Where this diagnosis obtains, the extremity should be put up in a position of marked abduction.

In children, a plaster of Paris spica may also be applied by suspending the patient in a Sayre's suspension apparatus.

Fractures of the Femur (Shaft)

The position occupied by the patient is the same as described for fractures at the hip. The cast should extend from the gluteal fold, and should include the foot at right angles. This form of cast is applicable to fractures involving the Knee Joint and for Fractures in the Upper Half of the Leg. (Fig. 21.)

Fig. 21. Plaster cast for fracture of upper half of leg. Note right-angled position of foot, and extent of cast.

Fractures of the Lower Half of the Tibia and at the Ankle Joint

These fractures are so severe and are accompanied with such deformity that they necessitate a narcosis to make the proper correction. Furthermore, if unattended by a wound they are *the* fractures of the lower extremity best suited for the ambulatory cast.

The patient occupies the supine position. The flannel bandage or tricot base (Fig. 22) extends from the condyles of the tibia, and the lower margin of the patella, and includes the foot—which is held at right angles by an assistant. (Fig. 23.) The crest of the tibia is covered with cotton wool to protect it from pressure. When there is no assistant to hold the foot, a muslin bandage sling is passed about the great toe (Fig. 24) and either held taut by the patient, if he be conscious, so as to bring the foot at right angles to the leg, or the strings of the bandage are fastened to the upper end of the table. About the condyles the plaster of Paris bandage is to be heavily applied so as to form a cuff.

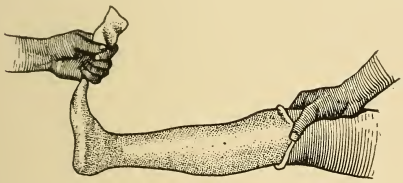

Fig. 22. Illustrating tricot hose investment in fracture of the leg.

The cast which is most desirable for *fractures at the ankle joint* differs from the preceding only in the very important particular, the position of the foot.

This variety of fracture is most commonly followed by flat-foot. To obviate this it will always be necessary to have the foot well inverted (varus) and at a right angle to the shaft of the tibia. Thus the patient is made to walk on the outer side of his foot. When it is intended that the cast should be an ambulatory one, a cuff of plas-

ter should closely hug the tibia and an extra number of turns of plaster of Paris should be passed about the

Fig. 23. Manner in which assistant holds foot for application of plaster bandage.

lower fourth of the leg, some of them embracing the ankle.

The upper limit of this plaster cast, while it must closely embrace the condyles, should not encroach upon the popliteal space where it would limit flexion at the knee joint. This is avoidable by cutting out a crescentic strip of plaster with the penknife while the bandage is yet in the plastic state. Other points of pressure in this cast are generally encountered on the inner and outer aspects of the foot. These are avoided by not carrying the turns of the plaster bandage so far forward as to impinge on the toes. If these pressure points do give trouble, greater relief will be afforded by splitting the bandage on either its inner or its outer side, than by cutting off any bandage in the circular direction.

Fractures of the Foot

A fracture of any of the bones of the foot may be very well treated by a plaster of Paris bandage, including the

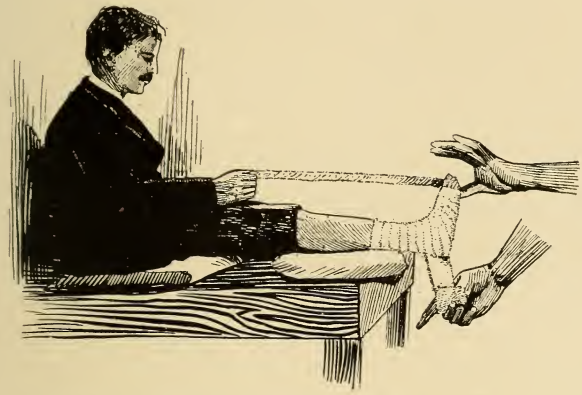

Fig. 24. Foot being drawn up at a right angle by a strip of bandage held by patient.

ankle and terminating over the lower third of the leg, below the level of the calf.

Caution: The dorsum of the foot should be well protected from pressure by a padding of non-absorbent cotton. When the metatarsal bones are fractured, a pad of piano felt should be placed on the plantar surface as an effort to preserve the transverse arch.

Fenestrated Plaster of Paris Dressing for Compound Fractures

This term applies to an ordinary plaster of paris bandage in a part of which a window is cut to permit of treating the underlying wound. (Fig. 25.) The opening in the cast should always be larger than the wound.

Methods of Fenestration

The window can be made in a variety of ways.

A. The wound, covered with appropriate dressing, may be included in the plaster of Paris dressing. Its location having been noted by measurement, a window corresponding to its dimensions is then cut from the plaster before it has set. The rough edges of the plaster bandage can be smoothed and still further protected from the discharge of the wound by investing the edges with adhesive plaster, or with gutta percha tissue made to adhere with chloroform.

B. The wound, duly protected, is covered with a measuring glass, a graduate or a tumbler of convenient size, the turns of the plaster of Paris bandage passing about the glass.

The Ambulatory Plaster of Paris Cast

The treatment of fractures of the leg and particularly those of the ankle, where there is no axial displacement of the fragments, demanding extension, are best suited for the "ambulatory cast."

Fig. 25. Showing plaster of Paris splint with two fenestræ.

It is the practice of some surgeons to have the upper limits of the cast at the condyles of the tibia, others would include the knee joint.

The indications for the choice of either may be set down as follows: Where the fracture is limited to the ankle joint a cast extending to, and embracing the condyles, is sufficient. All fractures above the middle of the leg call for immobilization of the knee also. Under these circumstances the cast should be carried up to the gluteal fold.

Experience has shown that no metal or wood strips need be incorporated in the plaster of Paris dressing. The ambulatory plaster of Paris splint differs from the ordinary plaster dressing applied for a like fracture, in the extent of the immobilization, in the greater number of the plaster of Paris bandages used, and in the increase in thickness of the plaster of Paris bandage by multiplying the turns at certain levels. The one situation favored by increase in thickness to prevent cracking, is just above the ankle joint. The upper limit of the plaster about the condyles of the tibia is also increased in thickness so that the weight of the body transmitted to the cast will not, in being transferred to the knee and thigh, cause the cast to cut into the soft parts, as would be the case with a thin edge of plaster. The ambulatory plaster splint is practicable in a fracture of the ankle or leg without a stirrup, by virtue of the mechanical fact that in a pillar, the stress and strain are distributed on the surface. Hence the column of plaster about the fractured leg carries, in greater part, the superimposed weight of the body. To give some elasticity to the rigid plaster beneath the plantar surface of the foot, some authorities advocate the insertion of a layer of felt.

The use of the ambulatory plaster of Paris splint does not imply that walking with a fractured limb will be possible at once. Only after several days, most commonly at the end of the first week, the patient can make efforts at standing and gradually, as he gains confidence, the limb can be used to walk with. In course of time the plaster of Paris on the sole of the foot softens. This may be unheeded, for with the free use of the limb the foot is protected with either a felt slipper or an arctic.

Fracture of the Patella

In very exceptional instances, where there is so scant a separation of the fragments that they can be approxi-

mated, as estimated by crepitus or the use of X-rays, the plaster cast surpasses all other forms of treatment.

The chief point to be considered in its application, is that the turns of the bandage must fit snugly about the upper and lower limits of the patella. This can be accomplished best by forcing the bandage down upon the patella while it is in the plastic state. Previous to applying the cast, approximation may be facilitated by passing adhesive straps obliquely about the upper and lower limits of the patella. Subsequent to the application of the plaster of Paris dressing, a radiograph may be taken, to ascertain the relation of the fragments. Inasmuch as it is to be the purpose to have the patient to walk about, the plaster of Paris cast should include the foot in a right angled position.

If the plaster cast be effective in maintaining the fragments, it may be removed after the lapse of two weeks, to permit of daily massage, and replaced each time.

Fracture of the Olecranon Process

This is referred to here for the application of plaster of Paris for this fracture corresponds in all essentials with its application for fracture of the patella, just described.

Compound Plaster of Paris Splints

Whenever additional material is incorporated among the layers of a plaster of Paris bandage, it is termed a "compound plaster of Paris bandage." These materials are incorporated to give additional strength to the bandage and incidentally to reduce its weight.

Strips of *veneering* (Figs. 26-28), tin and iron, wire netting and gutta percha are the materials most commonly employed. The metals are least desirable as they

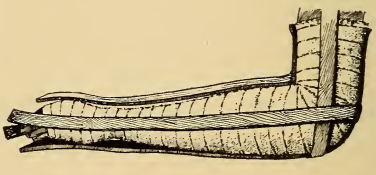

Fig. 26. Use of veneering strips to strengthen the cast.

are likely to become rusty, and by this corrosion, break and penetrate the bandage.

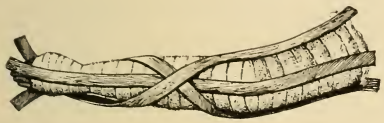

Fig. 27. Veneering strips spirally wound about the cast.

In dressing after resections of the elbow and knee, these compound plaster of Paris splints find their greatest usefulness. (Figs. 26, 27, 28.)

Fig. 28. Veneering strips placed the length of the arm.

Segmented Splints

When it is desirable to have access to the wounds of joints (or to wounds extending over a large part of the circumference of an extremity), so that they may be approached from all sides, the joint (or other surface), is bridged over with bands of metal, or with wire, which are incorporated in the turns

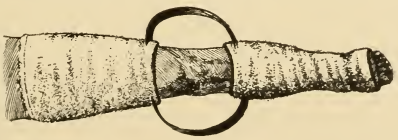

Fig. 29. Bridging strips of metal permitting motion and inspection of the joint.

of the segments of plaster above and below the joint, as shown in figures 29 and 30. A sufficient curvature is given to the strips so as to permit the joint to have some range of motion eventually.

Suspended Splints

A strand of wire with hooks may be incorporated in any variety of plaster splint. These hooks facilitate the suspension of the limb, as may be necessary in inflammatory conditions. (Figs. 30 and 31.)

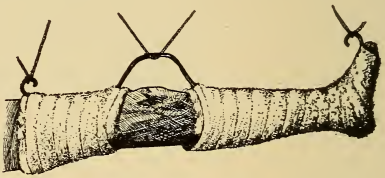

Fig. 30. Wire worked into the two sections of the plaster cast to facilitate suspension of the limb.

A fenestrated splint may also have wire and hooklets incorporated in it to permit of its suspension. (Fig. 32.)

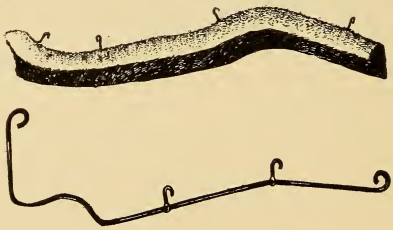

Fig. 31. (a) Molded splint with wire hooks for suspension; (b) the wire itself.

Heated Splints (Perthes)

In certain inflammatory conditions of the joints, notably in gonorrheal arthritis, in addition to the immobilization effected by plaster of Paris, it may be desirable to supply heat to the parts. When this is desired, there may

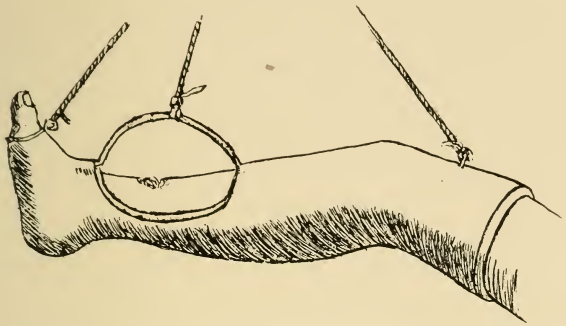

Fig. 32. Fenestrated plaster splint with wire and hooklets for suspension.

be wound about the cast coils of rubber tubing, or narrow tubing of lead or of flexible tin. Through this tubing very hot water is allowed to pass, and is carried off into a pail.

CHAPTER V

MOLDED PLASTER OF PARIS SPLINTS

Methods of Application

This variety of splint has thus far been but casually referred to in the previous pages. It may be made in a number of ways.

Pieces of gauze of several thicknesses, or a single layer of flannel, are first cut to the shape of the parts (antero-posterior or lateral aspects). They are then steeped and kneaded in a plaster of Paris paste. The member to be invested is thoroughly anointed with a thin layer of vaselin, and covered on both sides with the fabric impregnated with the plaster of Paris. (Fig. 33.) The latter is held in place by several turns of muslin bandage, until it hardens. (Fig. 34.) As soon as the setting is completed, the turns of the muslin bandage are divided, and the splints are set aside, to dry still further, if possible. They are then lined with non-absorbent cotton. (Fig. 35.) When applied, the splints are to be held securely in place by circular turns of adhesive plaster, one near each extremity of the splint and the other fastened in the center. (Fig. 36.) The two splints are then covered with a gauze or muslin bandage (Fig. 37), and this, in turn, is covered with a crinolin bandage, which prevents shifting of the splints.

The advantages of this variety of splint over the circular plaster of Paris bandage, consist in its lightness of weight, and the ease with which it can be taken off and

put back again, so as to enable inspection and to better the reduction of the fragments, if necessary.

Instead of impregnating the layers of gauze by steeping and kneading them in the cream of plaster, the latter may be poured on the gauze from a pitcher, and rubbed into the meshes with the hand. The impregnated gauze

Fig. 33. The impregnated plastic fabric applied to the forearm.

is then applied as in the previous method. This is a rather messy procedure.

A third manner of preparing molded splints is directly from a plaster of Paris roller bandage. A bandage of the desired width having been selected, it is cut in the necessary lengths, ascertained by measurement. To prevent the crinolin from curling up, a weight is placed upon either end. Warm water is then allowed to drip

on the several superimposed layers of gauze, to saturate them. They are then applied to the limb and molded in the same manner as described in the first method.

Again, the plaster of Paris roller bandage, having first been made plastic by immersion, may be cut in lengths to correspond to measurements of the extremity. Several

Fig. 34. Molded splint held in place while hardening.

such lengths are superimposed and then molded on the limb as described.

Finally, the moistened plaster bandage may be directly molded on the limb by playing the bandage to and fro upon it, each end of the bandage being held by an assistant, who grasps the successive turns as they are superimposed (Figs. 38, 39, 40), the surgeon at the same time stroking the bandage to make it adhere to the deeper

layer. The subsequent steps are identical with those mentioned above.

The Bavarian Splint

This variety of molded splints is made as follows: Two pieces of canton flannel, shaped to conform to the circumference of the fractured member, are sewn together

Fig. 35. Splint lined with non-absorbent cotton.

lengthwise through their middle, in single or double line of stitches, the seam always arranged to occupy the posterior aspect of the limb. One-half of the inner layer of flannel is then passed about the limb and secured, by several stitches or by adhesive plaster, to the underlying dressing (bandage). Plaster of Paris paste is then applied, and thoroughly rubbed into this layer of flannel. Before the plaster has dried the outer layer of flannel

Fig. 36. Anterior and posterior splints secured by strips of adhesive plaster.

Fig. 37. The bandage covering the splints.

on the same side, is superimposed. The two flannel layers on the other side are then similarly manipulated. When both halves have set completely, they may be cut down in front, and turned to either side, the seam posteriorly acting as a hinge, to permit of an inspection of the parts, after which they are turned back again and securely held

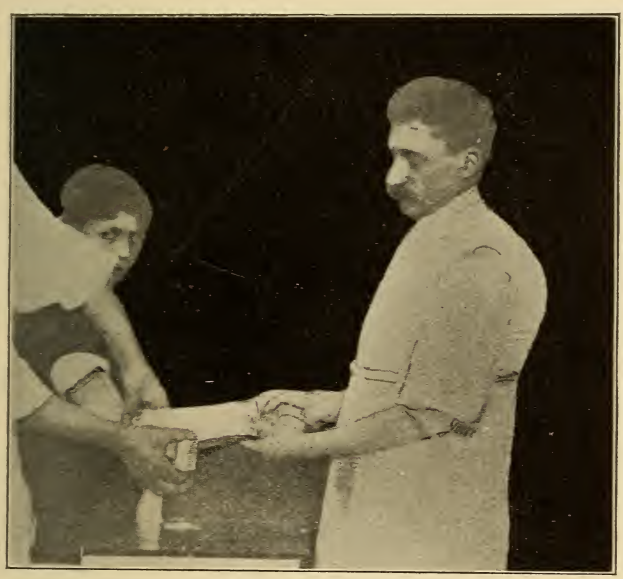

Fig. 38. To and fro passage of the plaster of Paris roller bandage.

in place with several strips of adhesive plaster, over which turns of a muslin bandage are passed.

The Hemp Splint

This is another form of molded plaster of Paris splint. A number of strands of hemp are beaten, then dipped into a paste of plaster of Paris and spread out over the limb, previously anointed with vaselin. Additional plaster of Paris paste is rubbed into the strands of hemp, and

more of the latter are added, from time to time, to impart the necessary thickness to the splint. First an anterior, and then a posterior, section is molded, and both are held in contact with the limb by turns of a muslin bandage. The latter is divided when the splints have hardened, and these are now lined with non-absorbent

Fig. 39. Molding splint for fracture of humerus.

cotton and securely held in place by strips of adhesive plaster and a muslin roller.

The Tricot Molded Splint

A length of tricot cylinder is filled with cotton or, preferably, strands of hemp. It is then dipped in the

paste of plaster and thoroughly kneaded therein. When completely impregnated, it is applied to the part and shaped to it by turns of a muslin bandage, which holds

Fig. 40. Molded splint for fracture of humerus suspended to dry.

it in place while it is hardening. Like the other splints, it is subsequently lined with non-absorbent cotton.

Molded Splint for Fracture of the Shoulder or Arm

This splint should be made to extend from the root of the neck to the elbow and to embrace the arm on all but

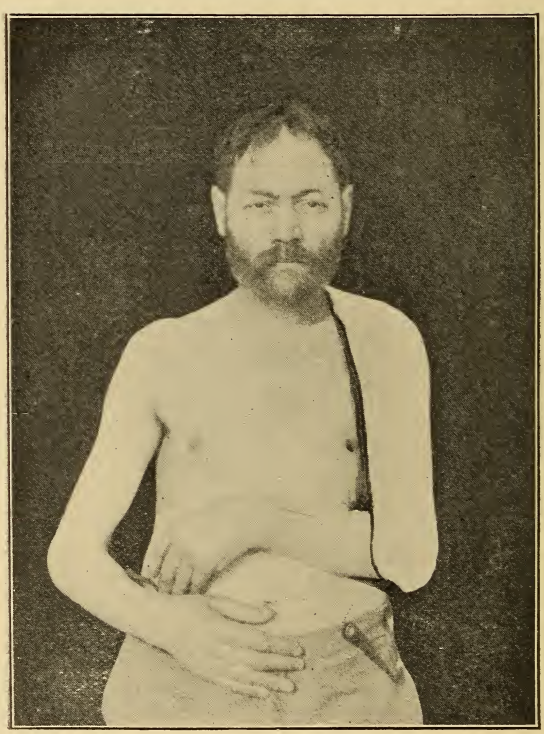

Fig. 41. Molded shoulder cap, front view.

Fig. 42. Molded shoulder cap, lateral view.

Fig. 43. Applying sugar-tong splint, the forearm in pronation.

its mesial side. (Figs. 41, 42.) With the aid of such a molded splint, we can attain complete immobilization when the splint is secured to the thorax with muslin and

Fig. 44. Holding taut the extremities of the sugar-tong splint.

dextrin bandages. The elbow being left free, it may act with the forearm as a counterextending factor.

Cole's Splint. Fracture of the Forearm

Here we may use an anterior, a posterior splint (Figs. 43 and 44), or, as in the "sugar-tong splint" of Cole, one piece hinged at the elbow. This latter splint is made by passing a plaster of Paris bandage from the wrist along the flexor aspect of the forearm, the latter being held in a position of pronation (Fig. 43), and then, turning about the elbow, the bandage covers the extensor surface of the forearm. The extremities of the bandage

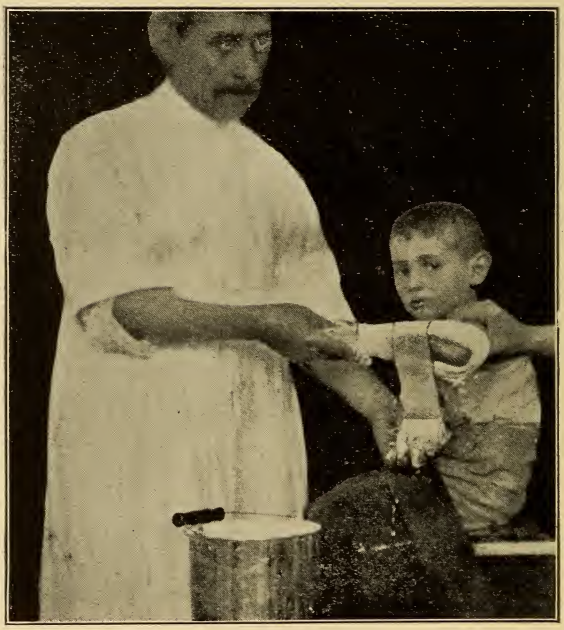

Fig. 45. Muslin bandage passed around the sugar-tong splint.

are held taut by the surgeon while it is setting. (Fig. 44.) The dressing is held in place by turns of a muslin

Braatz's Spiral Molded Splint

This bandage is suitable for fractures in the lower portion of the forearm or Colles' fracture. A strip of gauze impregnated with plaster of Paris paste, or tricot cylinder filled with plaster paste, is wound spirally about the forearm, beginning at the elbow, just beneath the internal condyle, then, passing obliquely over the flexor surface of the forearm, it turns about the radial side of the forearm, passing over the lower third of the radius on its dorsal surface, and terminates at the head of the metacarpal bones. (Fig. 46.) The splint is finally lined with non-absorbent cotton and covered with turns of muslin and starch bandages.

Fig. 46. Braatz's spiral molded splint for Colles' fracture.

Molded Splint for Fracture of the Forearm

Several layers of crinolin, of appropriate length, are dipped into a paste of plaster of Paris, and are then applied to the dorsum of the forearm, from the elbow to the heads of the metacarpal bones. The forearm is allowed to rest on the thigh (Fig. 47), and if the fracture be in the lower end of the radius or ulna the hand is sharply flexed at the wrist, grasping the knee. Before applying the splint, the arm is anointed with vaselin, in order that the mold may be easily removed after it has set. The splint is then lined with non-absorbent cotton, dusted with dermatol; and secured to the forearm,

first by adhesive straps one inch wide, then by muslin bandages, and lastly by a crinolin bandage. Instead of the layers of crinolin, a roller bandage of plaster of Paris, the width of the forearm, may be run up and down, and molded to the shape of the limb.

Fig. 47. Posterior molded splint for fracture of one or both bones of the forearm.

Gutter Splint

This splint is molded, in the same manner as the one just described, about the foot, which is to be in the right-angled position. It extends up the calf of the leg to the flexure of the knee joint or above. (Fig. 48.) It is suitable for fracture of the leg or injuries of the knee-joint, when ambulatory treatment is deemed inadvisable.

It is not eligible when there is any deformity, for the splint embraces but half the inner and outer aspects of

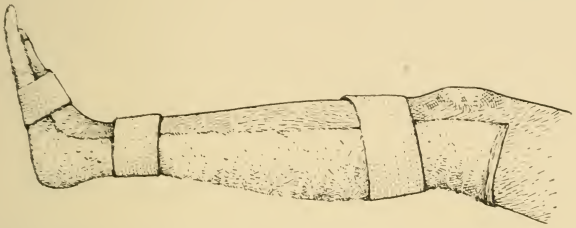

Fig. 48. Plaster of Paris gutter splint for fracture of one or both bones of the leg.

the leg. When dry, the splint is lined with non-absorbent cotton dusted with dermatol, and held in position by muslin and crinolin bandages, applied successively.

CHAPTER VI

PLASTER OF PARIS IN ORTHOPEDIC SURGERY

Plaster of Paris Corset

It was this device as taught by Sayre that gave the greatest impetus to the use of plaster of Paris dressings. The manner of its application laid down by him survives to this day as the chosen method. A plaster of Paris jacket may be applied with the patient either in the suspended vertical position (Sayre), or in the swaying horizontal, or recumbent position.

Vertical Suspension.—The patient is stripped of all clothing. The body is cleaned with soap and water, rubbed with alcohol, and freely dusted on all sides with talcum, dermatol, bismuth, or a mixture of these. While in a position as if crawling, *i. e.,* with the body's weight supported on the hands and knees, a seamless shirt or tricot hose is slipped on. If the latter is used, the upper end is fitted by slitting the hose in the axillary lines to a depth sufficient to bring the ends over the shoulder, where they may be tied, or secured with a few stitches or a safety-pin. All folds in the shirt are smoothed away by drawing it down and securing it snugly in the perineum with a safety-pin. The patient is lifted, with assistance if heavy, into the suspension apparatus of Sayre; for with a diseased spine, the patient should never assume, unsupported, the erect posture. The patient is suspended in the apparatus by the chin, with the arms extended and grasping the cross-bar to aid in the extension of the spine. (Fig. 49.) The ropes that are fastened to the cross-bar and play about the pulleys above, are drawn upon until

the entire body sways, and the tips of the toes touch the floor, or the stool placed beneath so that the patient's trunk is on a level with the arms of the surgeon seated and applying the plaster bandages. An assistant grasps the legs to prevent the swaying of the body, as well as its rotation, and to guard against the inadvertent flexion

Fig. 49. Application of plaster jacket in Sayre's suspension.

of the thighs. Another assistant controls the rope with one hand, and with the other steadies the extended arms of the patient, so as to prevent rotation of the cross-bar.

All the bony prominences, such as the spines of the ilium, and the gibbus itself, and also any very decided

hollow, especially about the waist line—if there be much lateral curvature or lordosis—are covered with a thickness of piano felt. This is to protect the prominences from pressure, and to fill in the hollows, so that the symmetry of the jacket may prevent the plaster from cracking. In each axilla felt or several thicknesses of gauze will protect the skin from the friction of the edges of the finished jacket. These pads are successively placed as the turns of the bandage are about to grasp them. It is no longer the practice to place a pad over the gastric area to make allowance for the full or empty stomach.

If the patient rests comfortably in the suspended position, the application of the plaster of Paris bandages may follow. The bandages should be four inches wide for the younger children, and for older children, of larger build, six inches. The bandages are passed circularly around the body. Below, the bandages should reach the great trochanters, and above, they should pass under the axilla and well over the top of the sternum. These limits of the jacket must be well borne in mind; for the commonly committed failure to observe them is chiefly responsible for ill-fitting corsets. If too short below, the jacket presses into the abdomen, or the latter bulges out beneath the edge of the plaster; if not carried high enough, the jacket fails to effect the necessary extension of the spine. After the setting of the plaster is completed the patient is to be lifted out of the swing. Being grasped by an assistant from behind, his hands passing beneath the axillæ, the patient is borne on the chest of the assistant, and is placed, temporarily, in the recumbent position.

Trimming the Jacket.—In order to allow flexion of the thighs on the abdomen a crescent of plaster of sufficient size is removed from each side, at the level of Poupart's ligament. To allow adduction of the arms a crescent-shaped piece is cut from the axillæ. The bandage must not be cut below the sternal notch, and a tongue of plaster must be left about the symphysis pubis. The

jacket must be cut on the sides until it conforms to the upper limit of the great trochanter. The patient now assumes the crawling attitude and the jacket is trimmed above, straight across posteriorly from the upper limit of one axillary fold to that of the other. Below, the excess of plaster is cut across posteriorly at such a level that the cast will not touch the chair seat when the patient is sitting. If there be any sinuses leading into old abscesses, the cast should be fenestrated, to admit of their being dressed. Any small decubitus (pressure sore) which is likely to form over the gibbosity may be dressed with balsam of Peru under the jacket without fenestration.

The shirt or tricot hose extending beyond the cast is drawn back over it and stitched together. This excess of hose not only imparts a neat finish to the jacket, but also prevents the rough cut edges of the plaster from pressing into the soft parts. When an excess of shirt or tricot is not available, the cast may be covered with

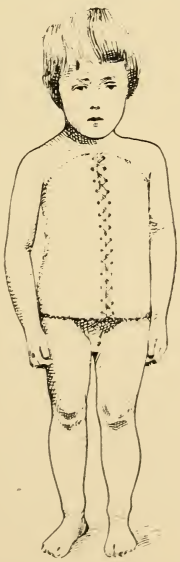

Fig. 50. Plaster of Paris jacket provided with hooks for lacing.

several turns of a crinolin bandage, and the cut edges covered with adhesive plaster. If the cast is to be a permanent one, it is now completed. If, however, it is to be a removable one it is to be cut down the front with a mitre saw or Stilles' bone forceps while the trimming is being done. The opposing front edges thus formed are bound with adhesive plaster and are fastened together with the same material. For long-continued wear, the edges should be bound with leather or canvas provided with a row of hooklets. These are stitched on and laces thrown about them. (Fig. 50.)

Jacket with Jury-Mast.—For the cervical form of Pott's disease, it is customary to incorporate a jury-mast in the dorsal part of the jacket. This latter device (as illustrated in Fig. 51), is a band of steel, its lower end having pieces of tin attached at right angles to facilitate its fixation in the plaster cast. It is bent to conform to the spine, and passes over the occiput to the vertex of the

Fig. 51. Plaster of Paris corset, with a jury-mast incorporated.

skull. At this point there is attached a short bar which plays on a pivot. From either end of the bar there passes a piece of webbing or leather strap around the chin to support the head. The band of steel should be so bent as not to touch the spine or the head. The degree of extension will be the greater the more the steel band is carried away from the head.

Horizontal Suspension.—When a suspension apparatus is not at hand, the patient may be placed in the horizontal position, face down, the body being stretched between two tables. (Fig. 52.) The shoulders rest on a pillow

Fig. 52. Application of plaster of Paris corset in horizontal position.

on one table, and the thighs on another. One assistant is detailed to apply traction to the thighs, and another, hooking his fingers in the axillæ, exercises traction upward. The weight of the trunk effects a lordosis, thereby overcoming any tendency to kyphosis. The same precautions are to be observed as in the vertical method, in covering any bony prominences. The plaster bandage is passed in circular turns around the trunk.

Goldthwait's Method.—A jacket may also be applied with the patient in a recumbent position, resting upon an appliance consisting of two wire supports, on one of which rests the sacrum, the other being placed beneath the deformity (with pads intervening). With hyperextension, a sufficient leverage is exerted to correct the deformity. The plaster bandage passes about the supports and includes the pads.

Horizontal Method in Hammock.—In place of the tables, again, a hammock made of extra stout muslin or canvas is suspended between two chairs, or two wooden horses, or over the ends of a bed. The patient is placed therein, face downwards, arms and legs extended. The plaster of Paris roller bandage, in its turns about the body, includes the hammock. On the completion of the bandaging, the excess of hammock is cut away. (Fig. 53.)

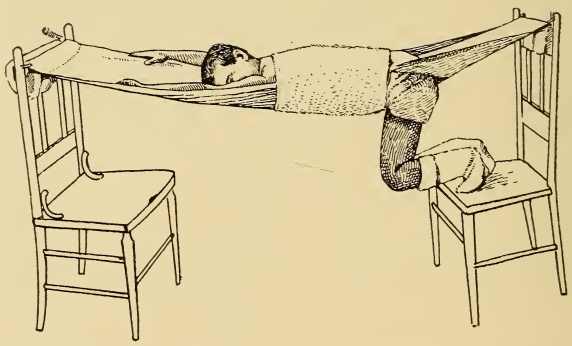

Fig. 53. Application of plaster of Paris corset by horizontal method in hammock.

The Bradford Frame is similar in application to the hammock. It is a rectangular frame constructed of gas pipe, over which is stretched a piece of canvas. The patient rests on this, face down, arms extended, the hands grasping the frame above, while the feet may be drawn down by an assistant; or each foot, with the

thighs in the abducted position, may be secured, with traction, to the lower part of the frame. A slit is then cut in the canvas on each side of, and parallel with, the body. Through these slits the roller bandage passes in its turns about the body, to include the canvas bed. The excess of canvas is cut away after the bandaging is completed.

Particulars About the Jacket.—The jacket should weigh between one and two pounds, and should be of uniform thickness throughout. If there is any decided acuity of the symptoms it is far better not to split the jacket, lest meddlesome guardians remove it too frequently. A well-fitting and comfortable jacket may remain in place for two months. At the expiration of this time the condition of the skin demands consideration, and the removal of the jacket is necessary for hygienic reasons. Thereafter it may be provided with hooks and laced, or brought together with strips of adhesive plaster, and so held in place.

A laced jacket is indicated in the less acute cases of spondylitis, and where extensive wounds require surgical dressing. Jackets are also indicated in cases of lateral curvature to supplement gymnastics, and for cases in which the distorted spine is painful. A plaster of Paris corset is also indicated in fracture of the spine prior to the performance of an operation, or when operation is contraindicated; and also after an operation has effectually reduced the fracture. In some very exceptional cases of rachitic curvature I have also applied a jacket with benefit, for it prevented the movements of a very tender spine until anti-rachitic treatment became effective.

It may at times be necessary to extend the plaster bandage so as to include the hip in a spica, as in sacro-iliac disease, or in a complicating hip-joint affection; and if the spinal disease be in the upper cervical region the turns of the plaster bandage should even pass about the shoulders so as to carry them well back.

The report of any pain, or the existence of any odor, about the jacket is indicative of an open wound. This, in the case of children, is commonly caused by the existence of a foreign body, playfully inserted or accidentally finding its way beneath the jacket.

A plaster jacket may be employed as a mold, from which, by filling the interior with a mixture of plaster of Paris, a cast of the deformity can be made. Over this cast corsets of other material—felt, wood, veneering, aluminum, and celluloid—may, in turn, be molded.

If a jury-mast be not obtainable, a crown of plaster of Paris may be passed about the head and this then joined by two steel bands passing to the plaster jacket and incorporated in its turns. (Fig. 54.)

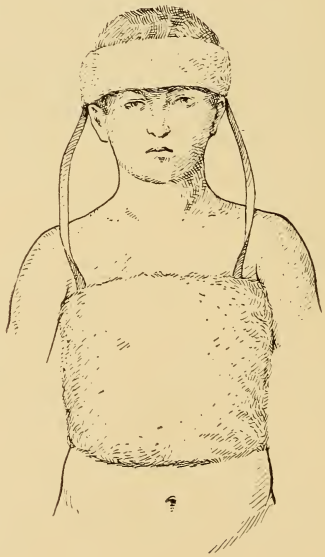

Fig. 54. Plaster of Paris corset and coronet united by bands of steel. Suitable for immobilization of the spine or for torticollis.

Lorenz Bed

In young infants who are to be carried about, a plaster jacket is impractical because of its weight, and because it impedes the thoracic movements. As such infants do not assume a sitting or an erect posture, they are best treated in recumbency. For this purpose the Lorenz bed is admirable. (Fig. 55.) It is a splint molded to

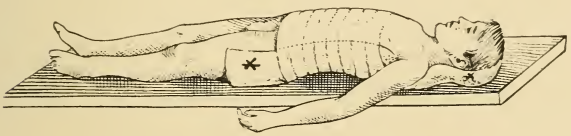

Fig. 55. Asterisks denote the Lorenz plaster of Paris bed for tuberculous spondylitis.

the contour of the spine, extending laterally to the posterior axillary line. When the disease is in the upper spine, it may be molded about the neck and head. It is to be padded with non-absorbent cotton, and secured to the trunk by turns of muslin and crinolin bandages.

Plaster Collar and Jacket

When the disease of the spine is high up in the dorsal region, or in the lower cervical, the bandages may be extended around the neck (Fig. 56) in figure-of-eight turns; or by like turns the head may be fixed; or a separate collar (Fig. 57) may be made, impinging upon the mastoid processes embracing the lower jaw, extending well onto the shoulders, and resting upon the clavicles. These plaster investments for the neck are indicated in the correction of torticollis, or after resection of the

sterno-mastoid for spasmodic torticollis, and for fracture of the cervical spine.

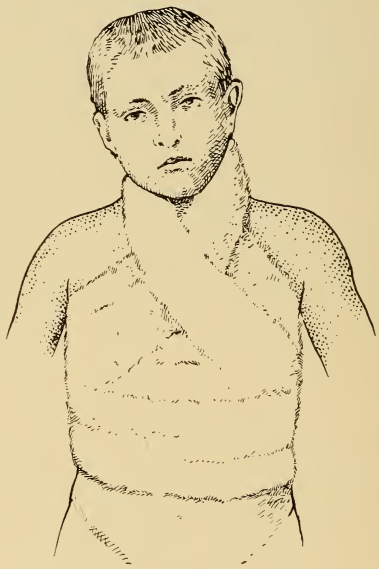

Fig. 56. Plaster of Paris jacket with figure-of-eight turns about the neck for cervical spondylitis or torticollis.

Torticollis

During the period of time, when non-operative measures are resorted to, in the hope of correcting wry-neck, the deviation of the head dependent on *congenital* spastic contraction of the sterno-mastoid muscle, may be overcome by suspension in the Sayre's apparatus. Where this can be accomplished, the position may be maintained by investing the body with a plaster of Paris jacket of light construction and extending it so as to pass about the neck in figure-of-eight turns (Fig. 56) or, if the

muscle be more unyielding, the plaster of Paris should also include the head, encircling the occiput and frontal bone.

In the *acquired* form of torticollis, which can be easily righted by manual force, the head can be retained in a corrected position by placing about it a coronet made of

Fig. 57. Plaster of Paris collar.

plaster of Paris, into which a metal ring is incorporated. by means of a muslin bandage passing through the ring and about the thigh, traction is made in a direction opposite to the existing torticollis. This traction is carried to the extent of producing a torticollis on the opposite side, thereby overcoming the spasm of the affected side.

For the torticollis of *cervical spondylitis* a well-fitting

plaster of Paris corset with a jury-mast from which the head is suspended, is the best form of treatment.

Hip Joint Disease

A plaster of Paris spica passing about the lower thorax and extending within a few inches of, and at times including, the knee joint, is an effective way of immobilizing the diseased hip joint. The spica is not to be applied, however, until flexion and abduction deformities have been overcome by extension with weights. The presence of a large, cold abscess, or sinuses leading into the bone or joint, contraindicate the use of a plaster of Paris spica.

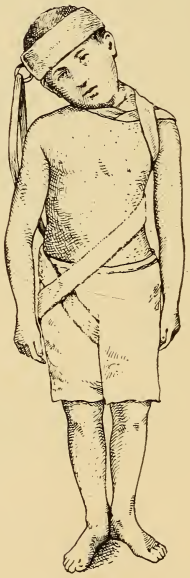

Fig. 58. Plaster of Paris coronet with ring incorporated to aid in correction of torticollis.

Even if it be desirable to apply some form of brace, or traction splint, the plaster spica may be retained when the tendency to flexion and abduction are marked. When

sole reliance for fixation is placed upon the spica, the immobilized, diseased side should be kept from the ground by the use of crutches. On the whole, it must be said, that the plaster spica, however well applied, is a bulky and unclean means of treating hip joint disease, as compared with some form of metal splint. As a word of warning, it should never occur to anyone to apply the plaster spica in order to *correct* a deformity.

Application of the Hip Spica.—The method of applying a plaster hip spica, described in fractures of the thigh, are equally applicable in hip joint disease. In addition to these, the following will be found useful. The head

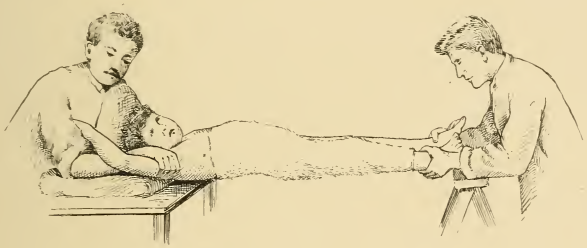

Fig. 59. Application of hip spica in the horizontal position.

and chest of the patient rest upon a table. Both limbs extended, and with the feet resting on another table or horse, are grasped by an assistant who exerts traction. Another assistant by hooking his hands into the axilla exerts counter-extension. With the body thus suspended, in the horizontal position, the plaster hip spica can be easily applied. (Fig. 59.)

Knee Joint Disease

An effusion of serum or blood in the knee joint, can very often be rapidly dispelled by the absolute immobilization afforded by a plaster cast, investing the thigh, including the knee joint, and extending down the leg below the calf. A cast of the same extent is necessary in

tuberculous disease of the knee joint, but not until the flexion deformity has been overcome by gradual extension, with weights and pulleys. The knee joint immobilized in the cast (of light construction) must not support the superimposed weight of the body, therefore crutches are to be worn or the knee, encased in plaster of Paris, is suspended in the Thomas splint for knee joint disease.

Ankle Joint Disease

In all affections of the ankle, there is a great tendency for the foot to assume a position of equinus combined at times with eversion (valgus). To forestall this, the foot must very early be placed in a plaster of Paris cast, in a position at right angles to the leg. Where there is much spasm of the tendo Achilles, this may be overcome by the administration of an anesthetic, and if there be still some difficulty, a subcutaneous tenotomy must be resorted to before applying the plaster cast.

Flat Foot

The rigid flat foot, with spasm of the tendo Achilles and lack of mobility of the smaller articulations, and abduction and eversion in the medio-tarsal articulation, calls for a correction which can be maintained only by a plaster of Paris dressing. To effect a correction, it is necessary to administer an anesthetic and manually force the foot into an exaggerated adducted (varus) position. It is thus maintained by a plaster of Paris dressing, which extends half way up the leg. This plaster cast remains on for four weeks. For the first three weeks the patient occupies the recumbent posture; thereafter he may walk about with crutches. At the expiration of the fourth week the dressing is removed and a plaster mold made, either from the dressing or directly from the foot. A sheet of steel is then hammered to conform to the plaster

mold, on its plantar surface, as far forward as the head of the first metatarsal bone, and to pass obliquely outwards back of the heads of the metatarsal bones, to the cuboid, the posterior limit of this splint corresponding to the middle of the os calcis. On the inner aspect of the cast the splint is hammered out in a semi-ellipse extending to the internal malleolus. On the outer aspect a

Fig. 60. Lorenz spica for unilateral congenital dislocation of the hip.

tongue of metal is hammered out as a guide to prevent the splint from slipping. This accurately fitted splint, thus hammered out over the plaster mold, is placed in the shoe, and, acting as a lever, it forces the foot into the correct position.

Congenital Hip Dislocation

One of the essentials in the successful treatment of a congenital dislocation of the hip is the application of a

well-fitting hip spica in which the patient walks about. An X-ray picture is first taken as a guide to the location of the head of the femur. Then follows a reduction of the head into the acetabulum, in which it is maintained by *abducting* the limb. In this abducted position the unilateral or bilateral spica is applied, according as the dislocation has been on one or on both sides. (Figs 60 and 61.) In addition to the abduction, the limb is slightly flexed and rotated in. The spica should preferably pass well up on the thorax, though this is by no means absolutely necessary. It should not extend below the knee,

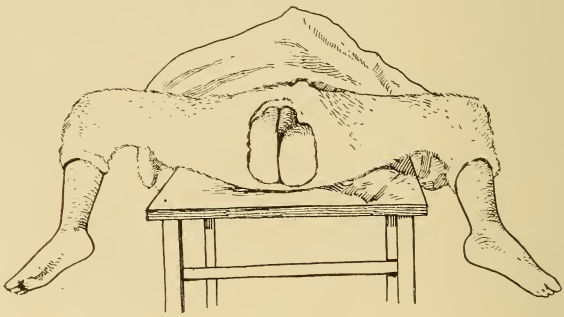

Fig. 61. Double spica for bilateral congenital dislocation of the hip.

in order not to interfere with comfort in walking. The plaster cast remains on at least six weeks. At the expiration of this time it is removed. If a radiograph then made shows the head of the femur in the acetabulum, the degree of abduction is lessened gradually. All the time that the cast is on, the patient walks about, thus aiding by this pressure, in forcing the head into the acetabulum and in shaping the latter. After the removal of the last cast, a hip splint is to be worn for some months.

Club Foot

The deformity known as club foot, if treated immediately after birth, and persistently, can be wholly corrected

by the use of plaster of Paris dressings, within a year or two. It is necessary, by a process of manipulations, as in modeling, to bring the foot from its equinus position into that of a right angle with the leg and to overcome the adduction (varus) and inward rotation. When these have been corrected a plaster of Paris cast is made to invest the foot, extending up the leg to the condyles of

Fig. 62. Wolff's method of removing wedge from cast to better the correction of the club foot.

the tibia. Great care must be taken in padding the bony prominences with non-absorbent cotton to prevent pressure sores. The best guarantee against decubitus, is a thorough reduction of all the abnormal positions that occasion the prominences. If the deformity cannot be wholly corrected at the first sitting it is remedied after the removal of the cast. With each renewal of the cast

another attempt is made to better the position of the foot. This correction of the very plastic tissues of the newborn and of the infant calls for no anesthetic. In adults, however, narcosis is necessary.

Wolff's Method.—The correction is effected under anesthesia, and a plaster cast is applied. While this is setting, further correction of the deformity is made by abducting the foot. Over the outer malleolus and over the tuberosity of the head of the first metatarsal bone fenestræ are cut to relieve the pressure. At the end of the first week a wedge is cut from the outer aspect of the cast (Fig. 62), and a linear division made about the ankle joint to the inner aspect of the foot. The removal of the wedge permits of crowding the foot outwards to effect a better correction. For this, and for succeeding corrections, rendered possible by enlarging the wedge removed, no anesthetic is called for. After each wedge cutting from the plaster, and correction, another layer of plaster of Paris is applied to hold the foot in its new position. When the complete correction of the foot has resulted, the cast is covered with strips of basswood veneering. These are secured in place by crinolin bandages, and coated with glue. A "water-glass" (silicate of soda) bandage is placed over all. The patient is allowed to walk about in this dressing for a month or a year, depending on the degree of severity of the condition.

CHAPTER VII

Plaster of Paris in Dental Surgery

All varieties of commercial plaster of Paris will make good models, but none other than recalcined plaster, sold in the shops under the name of French Dental Plaster, is suitable for making impressions.

Mixing the Plaster

Place four ounces of water in a bowl, preferably of rubber; but a glazed porcelain bowl will answer the purpose. It is advisable to have the plaster set as quickly as possible, therefore add a pinch of salt, alum or chlorate of potash. If none of these is at hand, warm water will hasten the setting. The addition of a few drops of essence of peppermint to the water will dispel the unpleasant taste of the plaster in the mouth. Take up the plaster on an ordinary spatula and sprinkle it on top of the water. Allow the plaster to be completely taken up before repeating this procedure; and do this a number of times until the water has absorbed all the plaster it can possibly take up. By following this slow method air bubbles will be prevented from forming. Then stir the mass with a spatula, *in one direction only*, until it has the consistency of a thick cream. Place it in the impression tray (Figs. 63

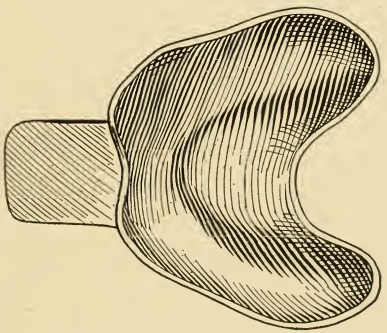

Fig. 63. Dental impression tray for endentulous upper jaw.

and 64), which should be previously selected to fit the mouth as nearly as possible, so that the minimum amount of plaster should be inserted in the mouth. If the impression is to be taken of the upper jaw, the tray should be first pressed up against the posterior aspect of the mouth, and subsequently the anterior part of the tray should be pressed into position in front. This will cause all surplus of plaster to be forced out of the mouth, thereby preventing gagging or nausea to a great extent.

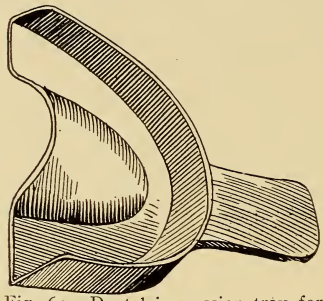

Fig. 64. Dental impression tray for upper jaw, some teeth being present.

Preparation of the Patient

Gagging, nausea and vomiting may be more certainly guarded against by spraying the palate and mouth with

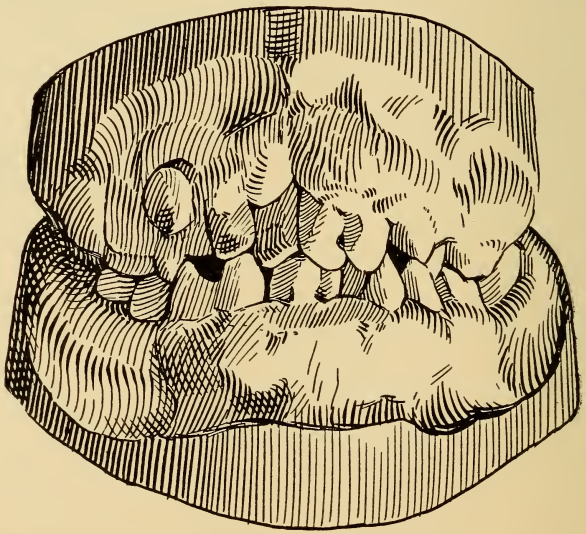

Fig. 65. Model of hypertrophied jaw.

a half of one per cent. solution of eucain or cocain, supplemented by the internal administration of a dram of aromatic spirits of ammonia. In sensitive patients, the best guarantee against nausea, etc., is the injunction to have the stomach empty.

Plaster intended for impressions of the lower jaw should be of such thick consistency that the tray may be inverted without the plaster falling therefrom. In taking an impression where it is impossible to withdraw it in one piece, it is desirable to mix with the plaster from one-third to one-half of ordinary precipitated chalk. This will cause the impression of fracture more readily and thus permit of replacing the parts afterwards, to make the model. In the case of cleft palates where a large fissure exists, it is advisable, prior to taking the impression, to either obliterate the fissure with softened beeswax, or absorbent cotton, or to bridge it over with adhesive plaster, the buccal surface of which must be oiled. The wax and cotton are apt to adhere to the impression, but if these precautions are not observed, the plaster of

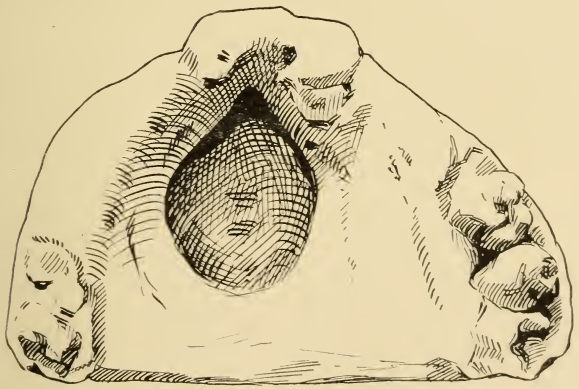

Fig. 66. Model of a syphilitic perforation.

Paris will run up into the fissure, and in withdrawing it a laceration of the soft parts may ensue. When the fissure extends to the soft palate, an impression of the

hard parts is all that is required, as the posterior portion is subsequently modeled in the mouth.

Difficult Impressions

Wherever there is a chance that the impression will be difficult to remove, as in the case of tumors of the jaw, it is advisable to oil the impression tray before placing the plaster in it. This will allow the tray to be removed, leaving the hardened impression in the mouth, thereby permitting the operator to cut it away in sections, which can be replaced in the proper position and a model made therefrom.

Impressions for Fracture of the Jaw

Impressions of a fractured jaw should not be taken in plaster of Paris, for modeling composition is far superior for this purpose.

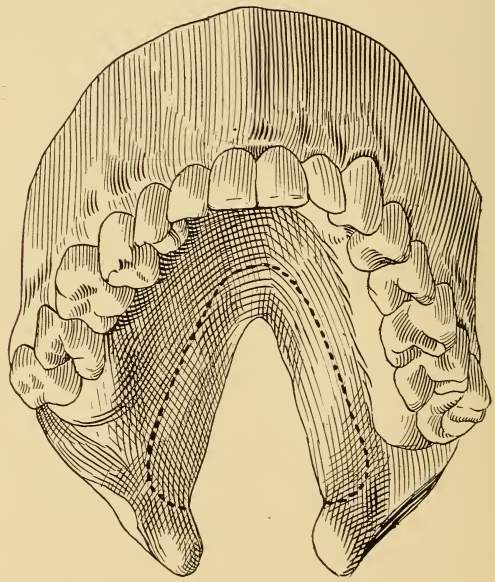

Fig. 67. Model of a cleft palate.

Where an operation is contemplated, it is advisable to take an impression of the mouth prior to the removal of the pathological condition (tumor), as this will serve as a guide in making the prosthetic appliance thereafter.

Making the Plaster Models

In order to obtain the best models it is absolutely necessary that the impressions be perfect, that all of these are in their proper position before the model is poured.

Plaster for models should contain the same ingredients as for impressions, but it should be somewhat thinner in consistency since it has to be poured.

The Separating Media Between Impressions and Models

To facilitate the separation of the impression from the model, a separating medium is necessary, so that one does not adhere to the other. Various solutions can be utilized for this purpose. A very thin alcoholic solution of shellac, or water-glass, or ordinary soapsuds, colored with

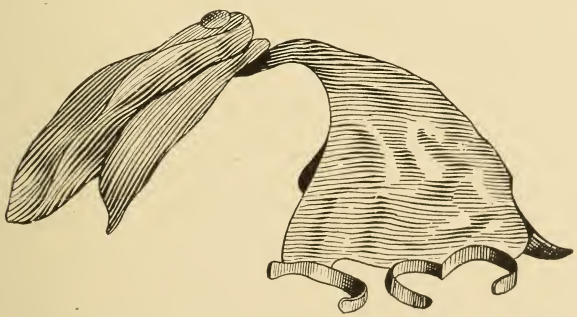

Fig. 68. Kingsley obturator for cleft palate attached to plate.

red ink to thereby indicate the line of demarcation between the impression and the model, will answer the purpose. Oil and vaselin should not be used, for they soften the surface of the model.

With a camel's hair brush, coat the impression with any of these separating materials and allow to dry. Then soak the entire impression in water of the body temperature. The object of this step is to facilitate the flowing of the model plaster into at the small crevices, which will not happen if the impression is dry. Place a small quantity of plaster intended for the model, on the highest portion of the impression, then tap the impression gently on the table or with the handle of the spatula, so

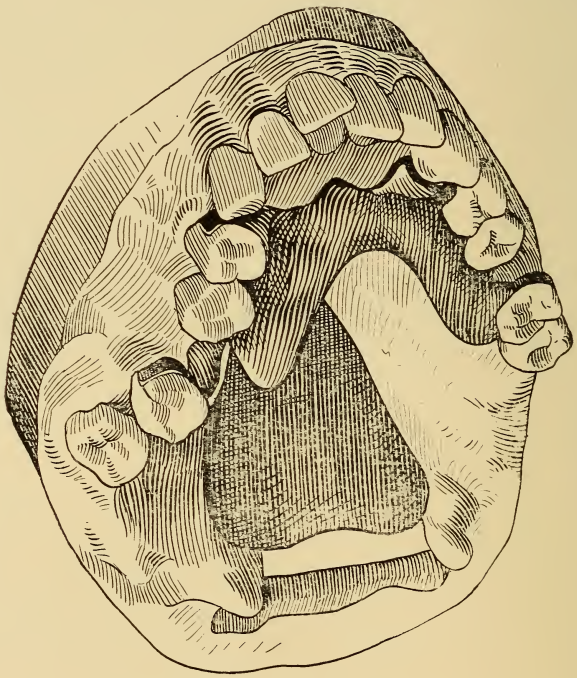

Fig. 69. Kingsley cleft palate obturator covering the cleft.

that the plaster will flow down into all the crevices and depressions. Repeat this as often as is necessary to build the models to the desired form. This will prevent bubbles, expel the air from the crevices of the impression and give a most satisfactory model.

After the plaster has hardened, place the whole in a pan of water, and allow it to boil five minutes. The expansion caused by the heat will facilitate the separation of model from impression. If it is a simple impression without undercuts to cause adhesion, merely tapping the model with the handle of the spatula will effect the separation. If the separation is hindered, however, by any irregularities in the impression, the latter has to be cut away in small pieces until the line of demarcation of the separating material is reached. This may be supplemented by occasional tappings with the handle of the knife to loosen the parts.

In making a plaster model from a wax, or modeling compound, impression, as in fracture of the jaw, wet the impression, pour the plaster in the same manner, allow it to set, place in a pan of cold water and *do not boil,* but merely heat it until the impression material is thoroughly softened, when it can be easily withdrawn from the model.

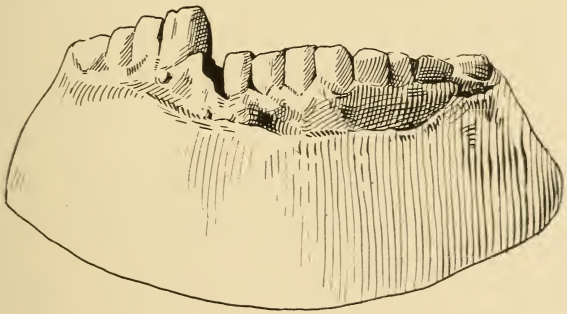

Fig. 70. Model of a fracture of the jaw.

Models should be neatly trimmed and dusted with talcum powder, to give them a smooth surface.

Interdental Splints

The first requisite is to take an impression in wax or modeling composition and then to make a plaster model of both jaws. (Fig. 70.) Then the model of the fractured jaw is so cut and replaced on an appliance for that purpose, known as an articulator (Fig. 71), as to bring the teeth of the upper and lower jaw in normal occlusion. On these models the model of the interdental splint is made in wax, and from this it is made in vulcanite (Fig. 72) or cast in pure tin. It is advisable to paint the cusps of the teeth on the models with several coats of shellac or to burnish over the cusps with No. 60 tin foil. The object of the latter procedure is that the indentations in the splint shall be a trifle larger than the teeth in the mouth, thereby permitting the reduction of the fracture more readily when the splint is inserted.

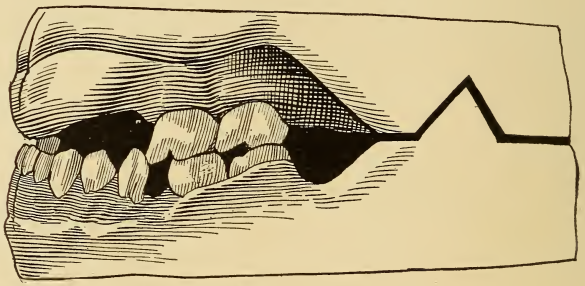

Fig. 71. Model of a primitive articulation in plaster.

If it is a difficult or painful procedure to insert the splint in the mouth, and reduction is possible forthwith, an anesthetic is administered to relax the muscles. When reduction is not possible at the first sitting, the splint may be inserted and a tight Barton's bandage placed about the head. In a few days normal occlusion will thus be attained.

Plaster Models of the Body

When the impression is to be made of a complicated part of the body, as a foot or hand, it is desirable to make it in two sections, and, furthermore if the part be covered with hair it had better be anointed with vaselin to prevent the plaster of Paris from adhering. The plaster for the first half of the impression may be of firm consistence and spread upon a layer of gauze. This half applied, the remaining surface of the part and the corresponding surface of the half of the impression that has been applied, are coated with a separating material (colored soapsuds, shellac or water-glass), and then the plaster of thinner consistence is poured over until it covers the part completely. When the plaster is set the impressions are separated. A model is made by tying the halves

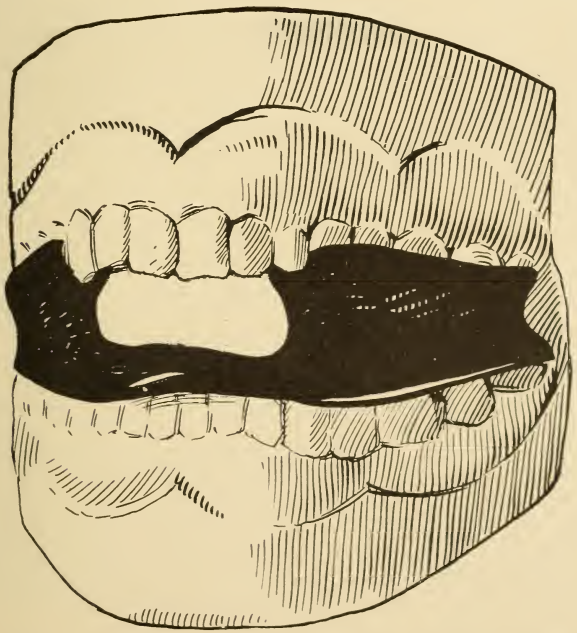

Fig. 72. Interdental splint with fenestra in the center for feeding.

of the impressions together after coating their inner surfaces with separating material (applied with a camel's hair brush), and then a thin cream of plaster is poured into the interior of the impression, into the furthest end of which a perforation is made to permit the escape of air, thus to avoid the formation of bubbles.

Repair and Preservation of Models

Any broken model may be repaired with cement. Models may be prepared for preservation by boiling in a solution of alum, and then coating when dry, with shellac.

Plaster Impressions and Moulages of Skin Diseases

To make wax models (moulages) of skin lesions, an impression is first made in plaster of Paris. This impression, when hard, is moistened in hot water, and then a mixture of melted beeswax, and spermaceti, equal parts, is poured on the impression. The wax model is easy to separate from the moistened impression. The coloring is subsequently imparted to the wax model with pigments.

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